



Earth System Research Laboratory

Serving society through science

esrl.noaa.gov

What Does the Earth System Research Laboratory Do for the Nation?



Recent Accomplishments

At NOAA's Earth System Research Laboratory (ESRL), scientists study atmospheric and other processes that affect air quality, weather, and climate. By better understanding the dynamic Earth system, we can better understand what drives this afternoon's haze, next month's hurricanes, and next century's climate. ESRL researchers monitor the atmosphere, study the physical and chemical processes that comprise the Earth system, and integrate those findings into environmental information products. Our work improves critical weather and climate tools for the public and private sectors, from hourly forecasts to international science assessments, with policy-relevant findings.

Benefits: ESRL data and discoveries let scientists and the public understand and predict climate variability and change and inform policy.

Understanding greenhouse gases and climate. ESRL has made unparalleled contributions to the scientific understanding of climate change, starting with its global atmospheric monitoring program, with more than four decades of measurements on the changing atmosphere and solar radiation. Building on that legacy, ESRL is part of a five-year international mission to gather detailed data on greenhouse gases and other pollutants, from pole to pole, at altitudes from 0 to 15 km. Researchers here also published findings on the 1,000-year-plus legacy of today's carbon dioxide emissions.

Benefits: ESRL improves the weather forecasts on which people, companies, and governments depend. The annual value of U.S. weather forecasts is estimated to be \$31.5 billion.

Supporting commerce. ESRL scientists help improve AWIPS, the forecast system used at NOAA Weather Forecast Offices around the country, work with the Federal Aviation Administration to improve aviation forecasts, and build next-generation models and data assimilation techniques that promise further improvements in skill, including hurricane track and intensity forecasts.

Benefits: ESRL provides crucial and unbiased information to help inform local, national, and international decisions about air quality, weather, climate, and risk.

Conducting "directed" science. ESRL research is focused on service to society. This year, that meant presenting experimental forecasts to officials preparing for the wildfire season. It meant studying the details of chemical, physical, oceanic, and atmospheric processes, to improve climate models for the Intergovernmental Panel on Climate Change. And it meant working with water resource experts and the managers of Western native lands to understand their data and forecast needs.

Benefits: ESRL develops state-of-the-art instruments to answer questions on the frontier of pressing issues, from hazardous weather to air quality to climate change.

Building tomorrow's instruments. Understanding the Earth system requires precise custom instruments. ESRL researchers built ASTER (Aerosol Scattering To Extinction Ratio) to better understand the warming/cooling effects of atmospheric particles. They patented AirCore, which collects air profiles from the top of the atmosphere to the surface. They improve operational forecasts with new instrument systems and GPS satellite observations through the Hydrometeorological Testbed (<http://hmt.noaa.gov/>) and other programs.



Top: A research jet prepares for a test flight in a pole-to-pole atmospheric mission. (NOAA).

Middle: Hurricane Bill in August 2009 (NOAA). **Below:** Lake Powell in 2005 (U.S. Bureau of Reclamation).

Bottom: A custom-built instrument for studying atmospheric particles. (NOAA)



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More Accomplishments

Benefit: ESRL educational programs contribute to a more scientifically literate society.

Educating future scientists and the public. ESRL researchers are collaborating with the Exploratorium in San Francisco, an internationally recognized science museum, to develop Earth science exhibits and programs. Science On a Sphere®, ESRL's unique visualization tool, is now in more than 40 locations worldwide and viewed by millions every year. ESRL hosted two "Teachers in the Lab" in a pilot NOAA program, helped run a climate workshop for weather forecasters, and published a quarterly newsletter.

Benefit: ESRL research provides a scientific basis for efforts to improve air quality, protecting public health and ecosystems.

Investigating air quality. ESRL scientists discovered how surface ozone levels unexpectedly soared above health-based standards during winter in rural Wyoming. They published work tracking springtime Arctic haze to biomass burning in Russia and Kazakhstan, and data showing how ship plumes impact regional air quality. ESRL also is continuing and building upon a long-term program to monitor tiny particles in the atmosphere that can harm air quality and affect warming.



"Teacher in the Lab" Diane Stanitski cleans an instrument during a research cruise. CSIRO photo.

Did You Know?



ESRL scientists helped create and continually update a coral bleaching outlook tool for reef managers and others concerned about productive marine ecosystems. The tool uses experimental sea surface temperature forecasts—developed at ESRL—to predict when and where the oceans might warm enough to trigger coral bleaching. Prolonged bleaching can lead to coral death. When reef managers and other users are alerted, they can mobilize monitoring efforts and develop responses to minimize some stress (<http://coralreefwatch.noaa.gov/>).

What's Next for the Earth System Research Laboratory?

- Expand global air sampling and other atmospheric and Arctic networks to accommodate a growing need to monitor the factors involved in warming and air pollution.
- Conduct measurements and analyses needed to support air quality forecasting.
- Establish hydrometeorology testbeds in at-risk regions of the Nation and transfer new technology to forecasting operations.
- Conduct regional and global research on the warming and cooling effects of particles, trace gases, water vapor, and clouds, and the interaction of climate and air quality.
- Develop Earth system modeling and assimilation techniques to support global chemical transport and regional climate simulations.
- Support NOAA in high-performance computing through new computing technology and improved software engineering practices.
- Define ESRL's and NOAA's roles in supporting the Nation's renewable energy development.

Research Partnerships

ESRL's partners include other groups in NOAA, the Cooperative Institute for Research in Environmental Sciences (University of Colorado at Boulder), the Cooperative Institute for Research in the Atmosphere (Colorado State University in Fort Collins), the National Center for Atmospheric Research (Boulder, CO), NASA, the Environmental Protection Agency, the National Science Foundation, the Departments of Energy and Homeland Security, and other academic and research institutions worldwide.

Budget and Staff

ESRL has an annual operating budget of approximately \$85M, 228 Federal employees, and 390 affiliates. Funding sources include Congressionally enacted budgets, funding provided by other NOAA entities where ESRL provides research support, and funds provided by other government and private sector partners who rely on ESRL-developed science and technology. ESRL headquarters is located in Boulder, Colorado.

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